HCAL SINGLE READOUT (TOY) SIMULATION

S. Abdullin, UMD

- Signal shape
- Signal collection in 2 and 3 time buckets
- Single readout response to fixed energy signal
  - 1, 3, 10 GeV
  - gaussian noise + ADC + photo statistics
  - baseline position : 1, 2 and 6th ADC channel
- Faking signal from noise : single readout occupancy
- Summary

SHAPE COMPONENTS

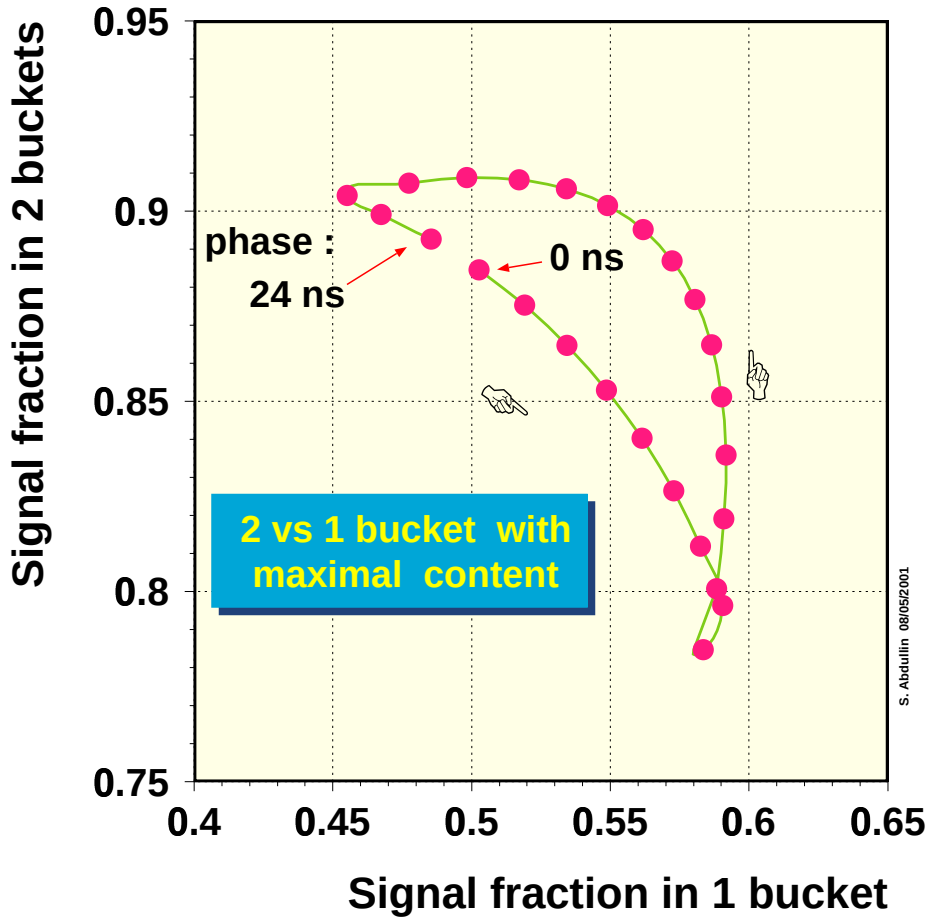
- **Scintillator + wave-length shifter**
  - $f_d(t) = \exp(-t/\tau_s)$, $\tau_s = 11$ ns
- **HPD**
  - $f_{HPD}(t) = 1.0 + (t/\tau_{HPD})$, $\tau_{HPD} = 10$ ns
- **Preamplifier**
  - $f_p(t) = t * \exp(-t/\tau_p)$, $\tau_p = 25$ ns

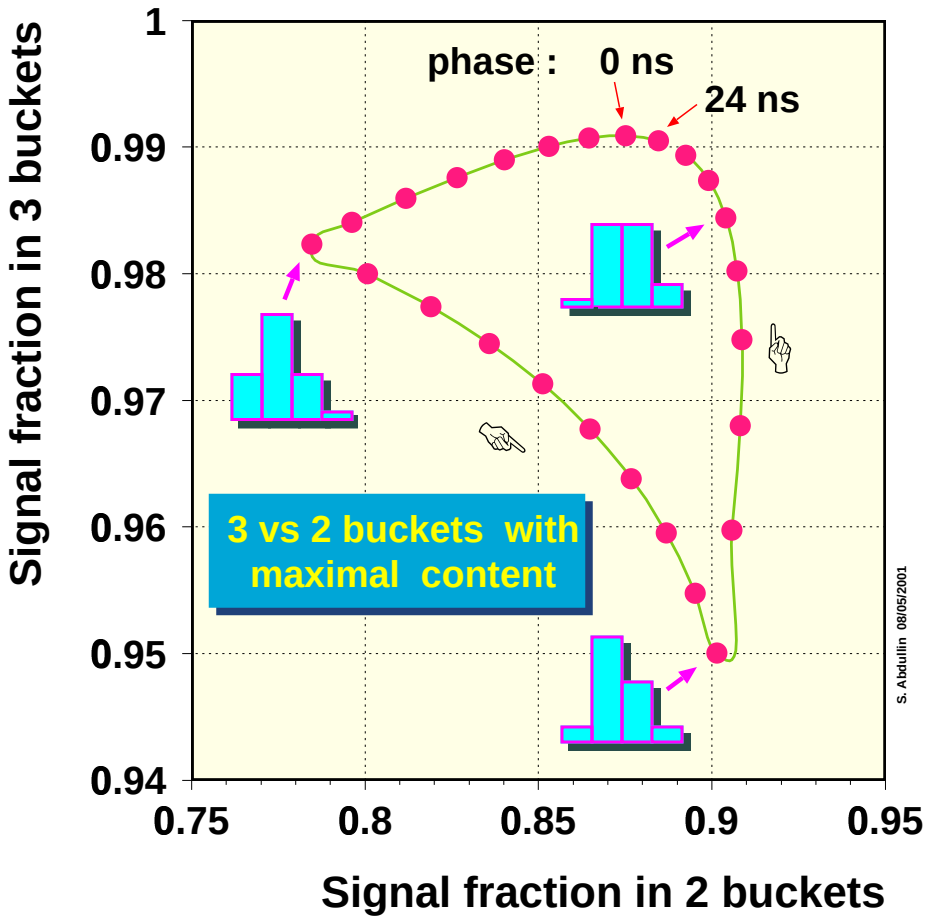
provided by Dan Green

peak time = 32 ns

- **Other contributions ?**

SIGNAL COLLECTION





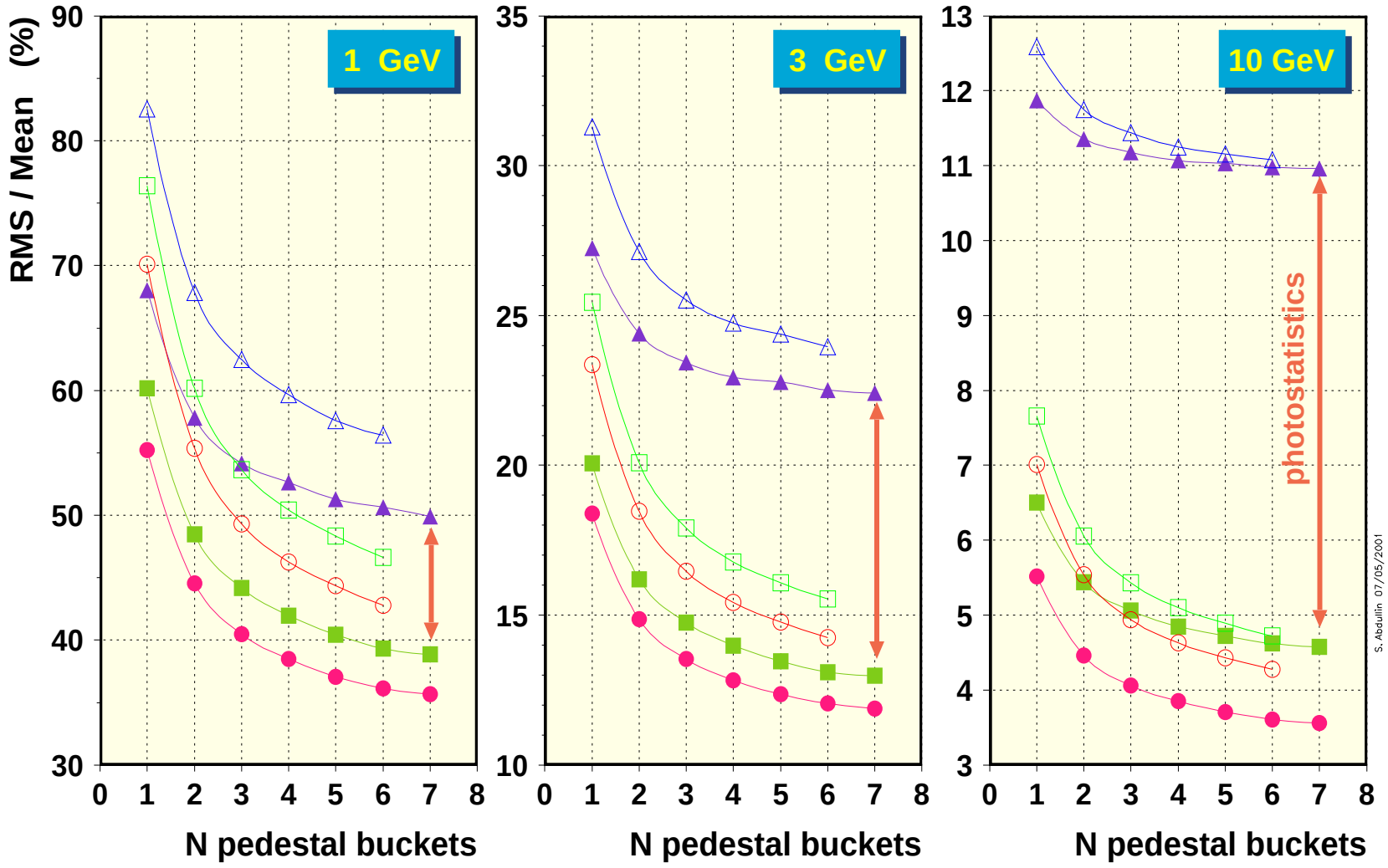
Calculational details

- parameterased signal shape = f(t)
  convolution of 3 shapes shown in the previous page
- t = time_of_maximum(32 ns) - tuning phase

SINGLE READOUT : CALCULATIONAL DETAILS

- Relevant weights are always applied to buckets, e.g.
  -0.5, -0.5, -0.5, -0.5, 1, 1,
  in case of 4 pedestal and 2 signal
- Gaussian noise = 200 MeV per bucket
- Baseline in 6th ADC channel (= 0 GeV)
  unless another channel is explicitly mentioned
- LSB = 300 MeV (effectively = 600 MeV for 10 GeV signal)
- No selection/suppression is applied
- Code -> energy assignment to the middle of the bin
- Baseline drift +/- 300-400 MeV practically
  doesn't change (as it shoud be !) the results

SIGNAL in a SINGLE READOUT (I)



signal collected in 2 buckets (~ 90 %)

signal collected in 3 buckets (~ 99 %)

● ○ Gaussian noise ■ □ + ADC ▲ △ + Photostatistics

SIGNAL in a SINGLE READOUT (II)

- **Baseline in the 6th ADC chanel : unbiased noise**
- **Electronics people : rather in the 2nd channel, or even in the first one (noise doesn't have negative values)**

1 signal + 2 pedestal buckets

Signal (GeV)	Baseline in the ADC channel # 1	2	6
1	0.882	0.995	1.001
3	2.879	2.993	2.999
10	9.883	9.996	10.004

offset (?) ~ 0.12

2 signal + 3 pedestal buckets

Signal (GeV)	Baseline in the ADC channel # 1	2	6
1	0.846	0.990	0.998
3	2.838	2.982	2.989
10	9.874	9.970	10.000

~ 0.15

3 signal + 3 pedestal buckets

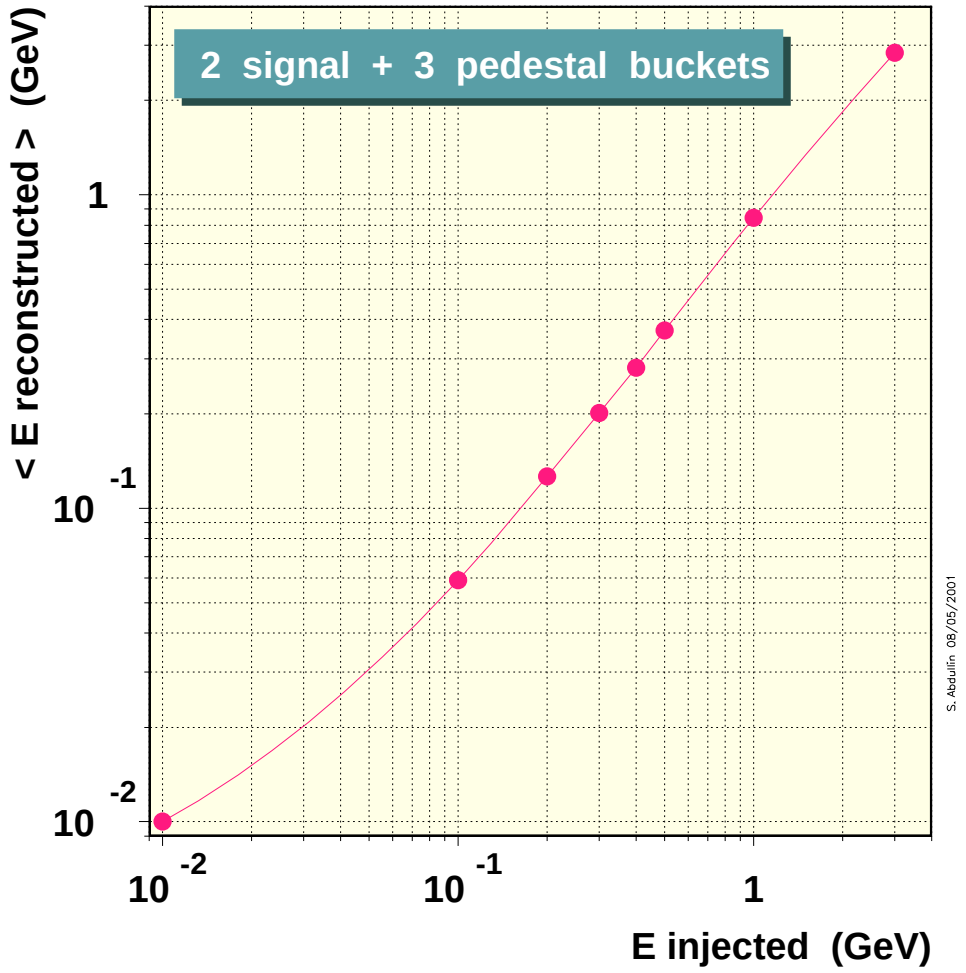
Signal (GeV)	Baseline in the ADC channel # 1	2	6
1	0.818	0.991	1.001
3	2.782	2.985	2.996
10	9.797	9.995	10.024

~ 0.20

< E reconstructed >

SIGNAL in a SINGLE READOUT (III)

Baseline in the 1st ADC channel



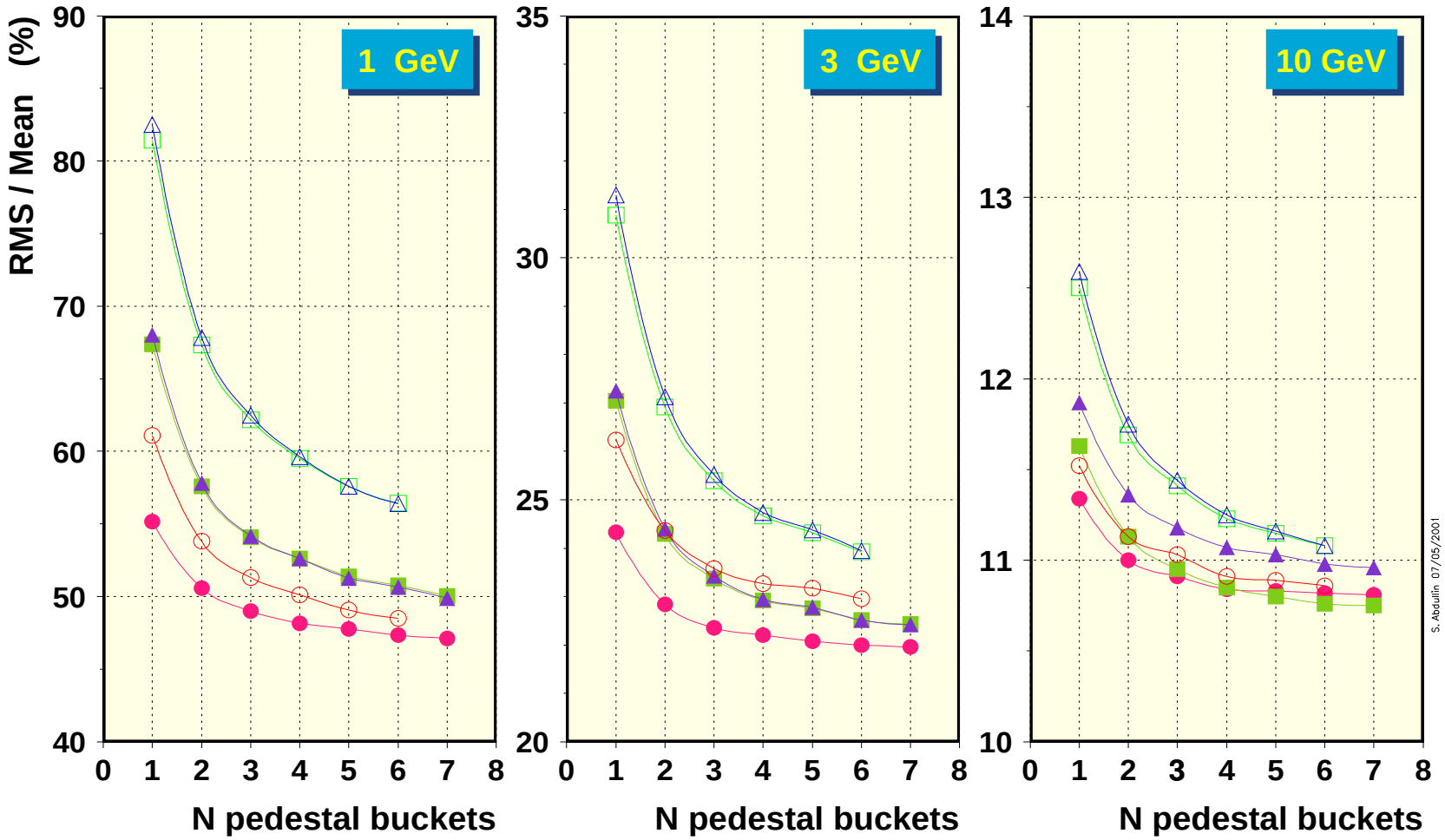
Doesn't look nice !

Is it possible to compensate non-linearity in a signal evaluation ?

hopefully YES, then ...

SIGNAL in a SINGLE READOUT (IV)

ADC + photo statistics

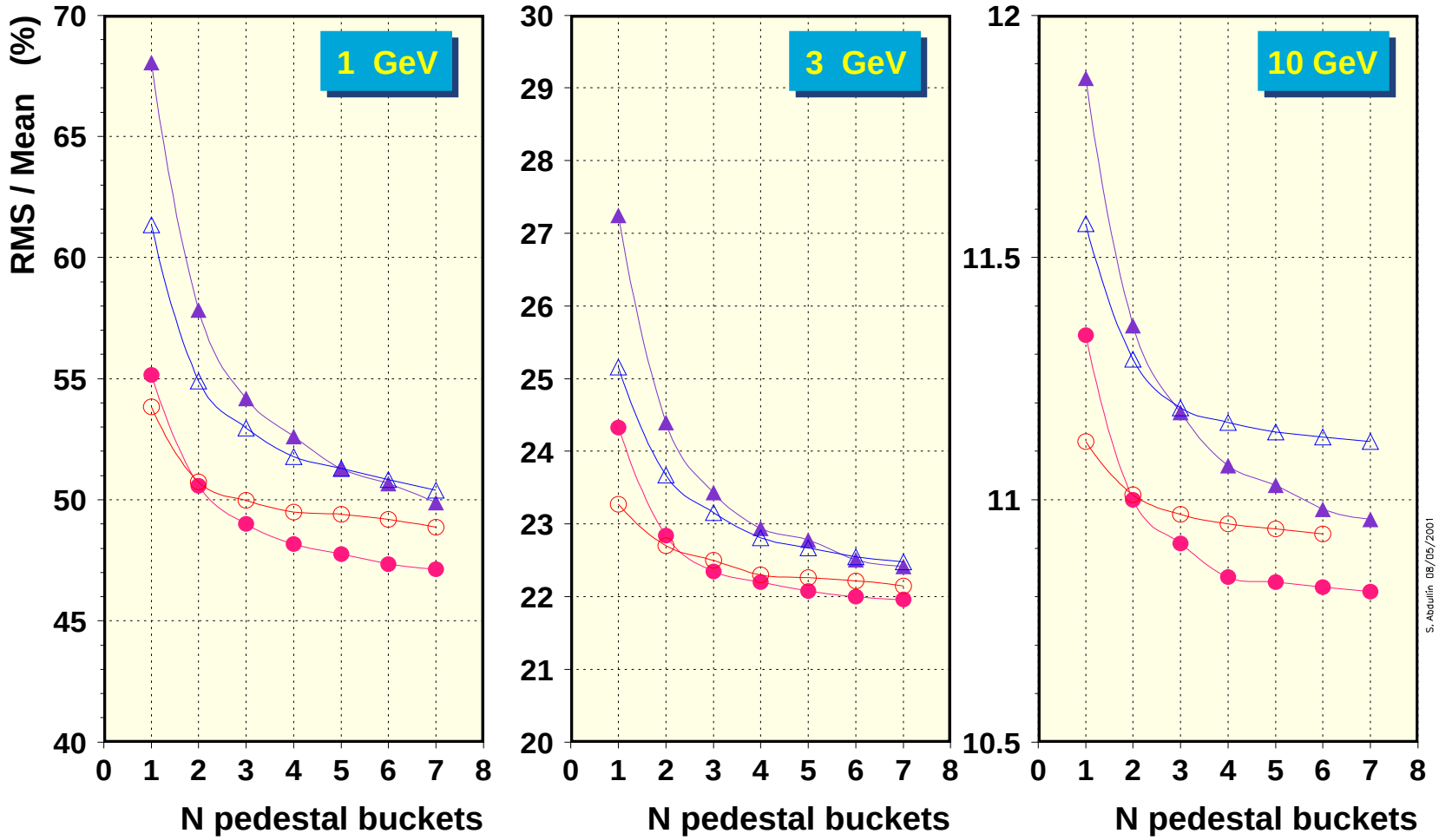


signal collected in 2 buckets (~ 90 %) signal collected in 3 buckets (~ 99 %)

- **Baseline in :** ● ○ 1 st ADC bin ■ □ 2 nd ▲ △ 6 th

SIGNAL in a SINGLE READOUT (V)

ADC + photo statistics

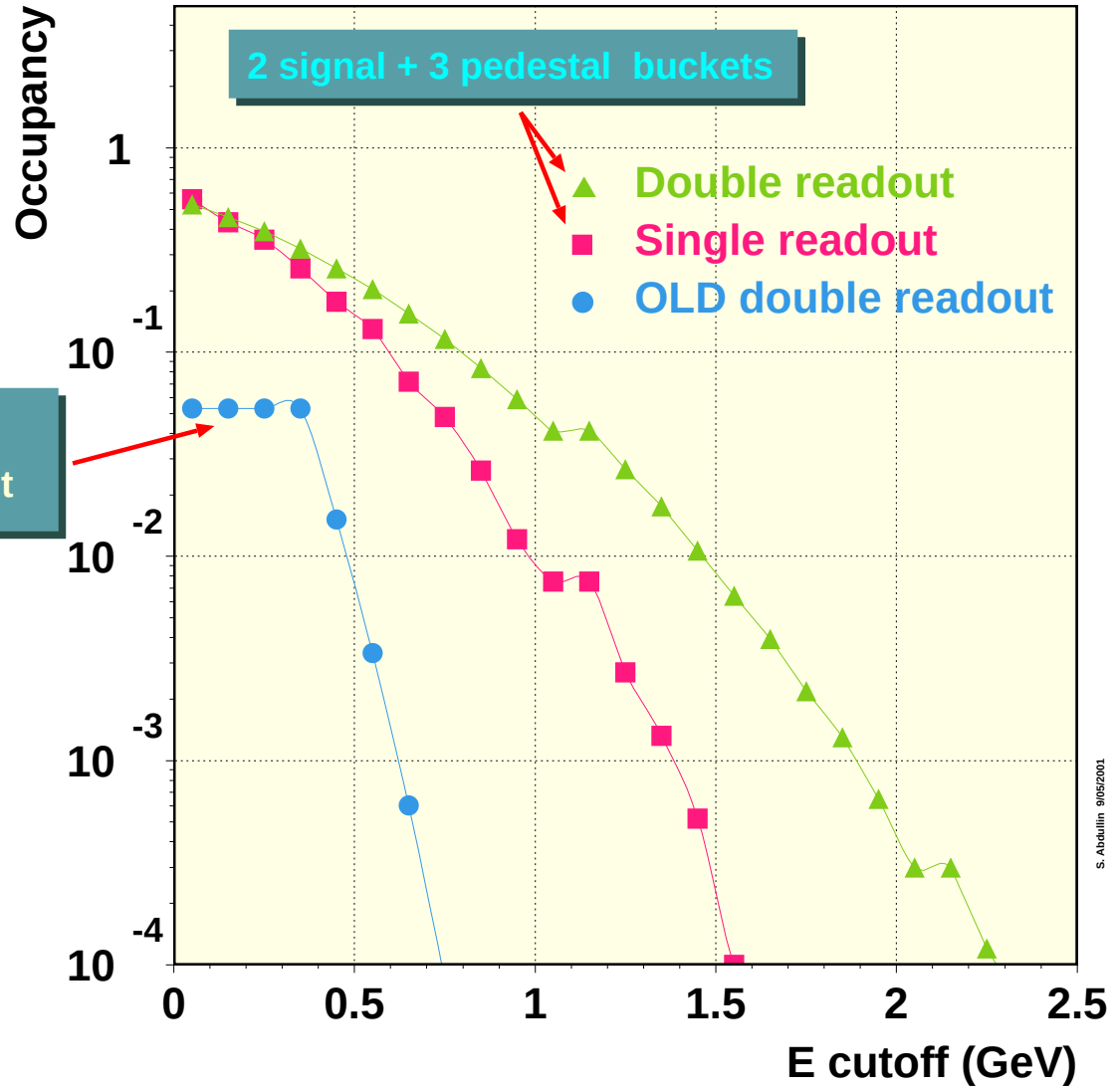


signal collected in 2 buckets (~ 90 %)

signal collected in 1 bucket (~ 59 %)

- **Baseline in :** ● ○ 1 st ADC bin ▲ △ 6 th

NOISE in a SINGLE READOUT



Artifact : HcalRecHit cut

MIP (muons) bit is to set for $1 < E_T < 3$ GeV

SUMMARY

- Signal collection in 2 time buckets, e.g. 2 signal + 3 pedestal, looks more attractive than collection in 3 buckets.

- Collected signal fraction ~ 90-91 % (2 buckets mode) is fairly stable in a time range ~ 4-5 ns.

- A one time bucket signal collection is quite stable within ~ 3-4 ns containing ~59 % of the entire signal. Results are suprisingly competitive with 2 buckets ones ...

- Baseline in the 1st ADC channel introduces "intrinsic" non-linearity (unlike 2nd and higher channels). In case of correction it gives slightly better resolution.

- Without any filtering/suppression the noise still is a worrisome issue even in case of a single readout.